

MEASURING PARTICULATE MIXING IN A STACK OR DUCT

Purpose This procedure is performed to determine the degree of particulate mixing in exhaust stacks and ducts for particles up to and including $10\mu\text{m } D_{ae}$.

Scope This procedure is used to perform field measurements of particulate mixing in exhaust stacks and ducts. ESH-17-121, "Sampling/Monitoring Radioactive Particulates, Tritium and Gases From Exhaust Stacks, Vents, and Ducts" dictates when to use this procedure and how to apply the results.

In this procedure This procedure addresses the following major topics:

Topic	See Page
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Hazard Control Plan The steps in this procedure are not performed by ESH-17 personnel; thus no ESH-17 HCP has been prepared. It is the responsibility of the supervisors of personnel performing this process to ensure all applicable hazards analyses have been performed according to applicable requirements.

Signatures
(continued on
next page)

Prepared by: _____ _ Victor A. Martinez, ESH-17	Date: <u>7/11/2000</u>
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Approved by:

—

Doug Stavert, ESH-17 Group Leader

Date:

7/19/00

01/08/03

General information about this procedure

Signatures (continued)

Approved by: _____ Scott Miller, Rad-NESHAP Project Leader	Date: <u>7/19/00</u>
Approved by: _____ Terry Morgan, ESH-17 Quality Assurance Officer	Date: <u>7/19/00</u>

Attachments

This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	MET One Performance Verification form example	1
2	Measurement Location, Setup, and Results form example	2

History of revision

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	11/27/96	New procedure
1	10/6/98	Revised to reflect new work control process. Update group names and add new procedure numbers.
2	7/24/00	Delete HCP reference, correct grammar and minor procedural changes.

Who requires training to this procedure?

The following personnel require training before implementing this procedure:

- ESH-17 and ESH-5 personnel responsible for performing measurements, analysis of results, and report preparation.

**Training
method**

The training methods for this procedure are:

- **on-the-job** training for technicians and staff members performing measurements. On-the-job training must be performed by an individual having the appropriate technical knowledge as determined and designated by the Rad-NESHAP Project Leader.
- **“Self-study”** (reading) for technicians and staff members supporting the measurements, analysis, and report preparation.

Training to this procedure is documented in accordance with the procedure for training (ESH-17-024).

General information, continued

Prerequisites In addition to training to this procedure, the following training is also required before performing measurements described in this procedure. This training is not required for personnel supporting the measurements, analysis, and report preparation.

- Radiological Worker 2 (Rad Worker 2)
- Site-specific requirements for each facility
- An “L” level security clearance is required as a minimum for some sites

Technicians responsible for the operation of the Met One should refer to the following documents for detailed operating instructions and safety precautions:

- Met One Laser Particle Counter Owner’s Manual
 - Labview Module Data Acquisition Software (LVSR01.VI) manual
 - Material Safety Data Sheet (MSDS) for liquid vacuum pump oil (di-2-ethylhexyl sebacate).
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Definitions specific to this procedure Aerodynamic Equivalent Diameter (D_{ae}): Diameter of a unit-density sphere having the same gravitational-settling velocity as the particle in question.

aerosol: an assembly of liquid or solid particles suspended in a gaseous medium long enough to be observed and measured; generally, about 0.001 - 100 μm in size.

Coefficient of Variation (CofV): The particle concentration standard deviation over a given area divided by the particle average concentration over the same area. May be expressed either as a fraction or a percent.

isokinetic sampling: sampling condition in which the air flowing into an inlet has the same velocity and direction as the ambient air flow.

NIST: The National Institute of Standards and Technology which provides traceable, certified calibration of many instruments and tools.

General information, continued

References

The following documents are referenced in this procedure:

- ESH-17-024, "Personnel Training"
- ESH-17-026, "Deficiency Reporting and Correcting"
- ESH-17-121, "Sampling/Monitoring Radioactive Particulates, Tritium and Gases From Exhaust Stacks, Vents, and Ducts"
- ESH-17-032, "Orienting New Employees"
- ESH-17-035, "Work Safety Review and Authorization"
- LIR 230-03-01, "Facility Management Work Control"
- LIR 402-10-01, "Hazard Analysis and Control for Facility Work"
- 40 CFR 60, Appendix A, Method 1, "Sample and Velocity Traverses for Stationary Sources"
- 40 CFR 61 Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities"
- ANSI N13.1-1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities"
- Met One, Model A2420, Laser Particle Counter Owner's Manual
- Labview Module Data Acquisition Software (LVSR01.VI) manual
- Material Safety Data Sheet (MSDS) for liquid vacuum pump oil (di-2-ethylhexyl sebacate).

Note

Actions specified within this procedure, unless preceded with "should" or "may," are to be considered mandatory guidance (i.e., "shall").

Background information

Background information

Department of Energy facilities which have a potential to emit radioactive particulates into the environment may require sampling in accordance with 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities." According to 40 CFR 61.93(b)(2)(ii), the "effluent stream shall be directly monitored continuously with an in-line detector or representative samples of the effluent stream shall be withdrawn continuously from the sample site following the guidance presented in ANSI N13.1 - 1969, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities" (including the guidance presented in appendix A of ANSI N13.1 -1969)." Los Alamos National Laboratory has received approval from the Environmental Protection Agency to use a single-point shrouded probe, which is an alternative sampling method. This alternative sampling method is performance driven. The sampling site must meet established criteria before a single-point shrouded probe may be used. Part of this criterion involves the degree of mixing at the sampling location. This procedure provides a practical approach to measure aerosol injected into an exhaust stack or duct so that the degree of particulate mixing can be determined.

Responsibilities

Responsibilities There are several critical tasks that are required to ensure accurate results are obtained from these measurements. Responsibility for each task is specified below. These may be changed, if appropriate.

Task	Responsibility
Obtain Stack Parameters (e.g. average velocity, diameter, etc.)	ESH-17
Prepare Site (e.g. scaffolding, etc.)	ESH-5, ESH-17, and JCNNM
Prepare Equipment	ESH-5 and ESH-17
Take Measurements	ESH-5 and ESH-17
Analyze Raw Data and Prepare Report	ESH-5 and ESH-17
Evaluate Results (not covered in this procedure)	ESH-17

Work control and worker safety

Overview	All work performed in a facility in support of the ESH-17 Rad-NESHAP Project must be coordinated with ESH-17, facility management, JCNNM, and ESH-5. All work described in this procedure will be performed in accordance with LIR 230-03-01, "Facility Management Work Control."
Hazards identified and documented by ESH-17	<p>Hazards identified by ESH-17 are listed below. The HCP associated with this procedure is located in the ESH-5 Group Office.</p> <ul style="list-style-type: none">• Radiation• laser light (see Met One Laser Particle Counter Owner's Manual)• rotating machinery (e.g., hand tools, pulleys, fans)• heights (e.g., roofs, scaffolding, ladders, bucket truck)• weather (e.g., lightning, snow, ice)• heat exposure• falling objects• compressed air• hand tools
Additional work not described in this procedure	If work not described in this procedure must be performed in order to obtain particulate mixing measurements, an ESH-17 engineer will review the work for safety considerations, document the results, and assist ESH-5 to complete or modify any required hazard control plan.
Facility check-in and check-out	Special check-in and check-out procedures must be followed while performing work in certain facilities. The ESH-5 lead technician will ensure that all check-in and check-out procedures are followed and that the measurement team is briefed prior to beginning work.
Permits	An ESH-17 engineer ensures all permits (e.g., radiation work permits) are issued before work begins.

Work control and worker safety, continued

Facility ES&H hazard analysis An **ESH-17 engineer** will contact and work with facility management to ensure the requirements of LIR 230-03-01, "Facility Management Work Control" and LIR 402-10-01, "Hazard Analysis and Control for Facility Work" have been appropriately addressed.

The following types of hazards may also be present in a facility while performing work to this procedure and must be identified during the facility ES&H hazard screening:

- chemical emissions
 - rotating machinery (e.g., hand tools, pulleys, fans)
 - noise
 - heat exposure
 - electricity
-

Unusual radiological hazards Before scheduling access to roof tops or opening stack measurement ports, the **ESH-5 lead technician** contacts facility management to determine if planned laboratory processes could produce unusual radiological hazards during the time personnel plan to be working with the stacks.

Potentially contaminated equipment The **ESH-5 lead technician** contacts the site radiological control technician to clear equipment used to measure particulate mixing in potentially radioactive stacks in accordance with facility requirements. If radioactive contamination is detected, the equipment must be decontaminated by trained and qualified personnel before being removed from the site.

Personal protection equipment Safety shoes and safety glasses must be worn while performing all particulate mixing measurements. Additional personal protective equipment may be required based on the facility ES&H Hazard Analysis.

Performing work safely **DO NOT perform work under conditions you consider unsafe.** Before beginning work described in this procedure, review safety needs and requirements. Be aware that facility configurations and hazards may change between visits.

Equipment

Equipment and required calibrations The following equipment is required to perform this procedure. Required calibrations and/or specifications for each piece of equipment are also listed, where applicable.

Equipment	Calibrations/Specifications
Velocity meter or pitot tube and manometer	Annual calibration of the velocity meter or manometer is required. The pitot tube must meet the dimensional requirements of 40 CFR 60, Appendix A, Test Method 2.
MET ONE Laser Light Scattering Spectrometers (two total: one as the reference counter, one as the traversing counter)	Factory calibration of the spectrometers must have been conducted within one year of use. The spectrometers must be capable of 2 acfm flow rate. The spectrometers must have a minimum of five sizing channels or ranges. At least one of the channels must record (count) particles of 10µm. The laser light scattering spectrometers presently used are manufactured by MET ONE, Grants Pass, OR.
Surrogate Aerosol	The aerosol source material must be non-hazardous, chemically inert, relatively nonflammable, and nonradioactive. Presently, a liquid vacuum pump oil (di-2-ethylhexyl sebacate) is used as the source material.
Aerosol Generator	The generation device must aerosolize the source material to an aerosol containing greater than 0.1% (by number) of particles over 10µm aerodynamic equivalent diameter (D_{ae}). At present, a pneumatic nozzle-type generator developed in-house is used in conjunction with a commercial air compressor to provide the surrogate aerosol that is injected into the stack or duct.
Isokinetic Sampling Nozzles (two per stack: one for the reference probe and one for the traversing probe)	Isokinesis must be based on the average effluent velocity at the measurement point. ESH-5 designs and fabricates the nozzles in-house.
Laptop Computer	The computer must be rugged enough for field use. It must also be able to interface with two aerosol spectrometers and be capable of running the appropriate acquisition and analysis software.

Equipment, continued

Equipment	Calibrations/Specifications
Dry Gas Airflow Meter	The dry gas meter is used to ensure that the airflow rate of the MET ONE is in calibration and that the air pump is working properly. The calibration of the dry gas meter must be current.
PSL Particles	NIST traceable polystyrene latex (PSL) particles of at least three different diameters in the same size range expected in the surrogate aerosol.
Absolute Filter	A filter capable of filtering ambient air well enough to demonstrate zero counts.

MET One performance verification

Overview Before the MET ONE is used to perform aerosol measurements, a performance verification test must be conducted. This test consists of checking the airflow calibration and performing a zero count purge. In addition, the factory calibration of the MET ONE must be verified at least annually. Conduct this test after the factory returns the unit from calibration and before it is used in this procedure. This calibration verification is conducted using monodisperse NIST traceable polystyrene latex (PSL) particles of at least three different diameters in the size range expected in the surrogate aerosol.

1. MET ONE Information Record the MET ONE model number, serial number, calibration expiration date, and LANL number on block 1 of the MET ONE Performance Verification form (Attachment 1) . Complete this form for each MET ONE used to perform aerosol measurements.

2. A. Airflow calibration check Use a calibrated dry gas airflow meter to check the MET One airflow rate and verify that the air pump is working properly. Conduct this test before each use of the MET ONE.

Steps for airflow check To conduct a MET One airflow check, perform the following steps:

Step	Action
1	Be sure you are wearing safety shoes and safety glasses .
2	Connect an airflow meter to the sensor inlet tube.
3	Turn the MET ONE 'ON' then press 'OPER'. Allow several minutes for the pump and airflow to stabilize.
4	Adjust the 'AIR FLOW' control to its minimum and maximum flows.
5	Adjust the 'AIR FLOW' control until the airflow meter indicates a flow rate of 2 acfm.
6	Turn the MET ONE OFF and remove the airflow meter.
7	Record the date and results in block 2 on the MET ONE Performance Verification form (Attachment 1).

MET One performance verification, continued

2.B. Zero count purge test

This test is used to verify that particles have not contaminated the MET ONE's sensor. This test should be conducted before each use of the MET ONE. Zero counts is defined as less than 500 total counts per minute and less than 10 counts per minute of 10 μm particles.

Steps to conduct the purge test

To conduct the zero count purge test, perform the following steps:

Step	Action
1	Be sure you are wearing safety shoes and safety glasses .
2	Connect an absolute filter to the sensor inlet tube.
3	If the MET ONE 'zero-counts, as defined above, the MET ONE is functioning within specifications. Go to the <i>Background determination</i> chapter of this procedure.
4	If the MET ONE is not able to 'zero-count' within a reasonable amount of time, the sensor should be purged. To purge the sensor, allow the counter to run for 24 hours at maximum airflow with an absolute air filter in place. To save paper, select 'Disable Printer' mode.
5	If, after purging, the MET ONE is still not able to 'zero-count', there may be internal problems or the MET ONE may need to be recalibrated. Return the MET ONE to the factory for repair.
6	Record the date and results of this check in block 2 on the MET ONE Performance Verification form (Attachment 1).

MET One performance verification, continued

3. Calibration verification check method This method requires a near-isokinetic sample to be withdrawn from the chamber. The Airflow Calibration Check should be performed prior to starting this check. The PSL concentration may be kept constant so that the MET ONE total count is in the 1×10^5 counts per minute(cpm) range. **Repeat this test three times, once for each particle size.** Allow the chamber to purge itself of aerosols between tests and clean the PSL generator(s) between tests.

Steps to verify calibration To verify calibration using the wind tunnel, or dynamic environment check method, perform the following steps:

Step	Action
1	Be sure you are wearing safety shoes and safety glasses .
2	Generate aerosols using one size of the NIST traceable PSL and inject them into the test chamber.
3	Insert the appropriate isokinetic sampling nozzle into the chamber and connect it to the MET ONE sensor inlet tube .
4	Set the MET ONE to sample at approximately one minute intervals obtaining at least a ten second sample.
5	Allow the PSL concentration to build so that the MET ONE total particle count is approximately 1×10^5 cpm.
6	Compute the size distribution indicated by the MET ONE for each sample using the ESH-5 Quattro Pro or Excel MET ONE-DST program, or if available, using an Aerodynamic Particle Sizer to determine the particle size distribution.
7	Verify that the calculated median particle size is counted in the correct spectrometer channel. If the MET ONE does not perform as indicated by these tests , the counter may need recalibration or repair. Refer to “Shipping Instructions” in Section 1 of the Owners Manual for information on returning the MET ONE to the factory for service.
8	Record the date and results of this check in block 3 on the MET ONE Performance Verification form (Attachment 1).
9	Complete block 4 as appropriate and sign and date the form.

Measurement preparations

- Measurement preparations** Several tasks must be performed prior to actually taking measurements. These tasks are intended to:
- ensure accurate measurements,
 - minimize the time required to take the measurements,
 - reduce the impact on facility operations, and
 - ensure work is performed safely.

Steps to prepare for measurements To prepare for taking measurements, perform the following steps:

Step	Action
1	Complete the required site-specific training, if appropriate.
2	The ESH-17 engineer assists ESH-5 to submit a Radiation Work Permit (RWP). After ESH-1 has completed the RWP, ensure that all participants have read and signed the RWP before any work begins.
3	Describe the measurement location in block 1 on the Measurement Location, Setup, and Results form (Attachment 2).
4	Obtain a copy of the most recent velocity profile measurement from ESH-17. Ensure that no ventilation system changes have occurred since the velocity profile measurement was performed. From the velocity measurement report, record the average velocity (and the center point velocity for round stacks/ducts), and the report date in block 2 on the Measurement Location, Setup, and Results form (Attachment 2). Use this velocity to select a sampling nozzle sized to ensure slightly subisokinetic sampling at a 2 acfm sampling rate. Record the sample nozzle serial number and internal diameter on the form.
5	Record the exhaust stack/duct dimensions in block 3 on the form. For round stacks, record the diameter. For rectangular exhaust stacks, record the width and depth (distance into the stack). From 40 CFR 60, Appendix A, Method 1, determine the number of traverse points and the required spacing. Also include a measurement point at the center of the stack and a measurement point 1 inch from each wall. Using a grease pencil, mark each sample tube with the appropriate dimensions before starting the field measurements. Record the number of traverse points, the spacing distances (to the nearest 1/8 inch), and the traverse directions (north-south, east-west) in block 3 on the form.

Steps continued on next page.

Measurement preparations, continued

Step	Action
6	Before performing work at the measurement location, be sure you are wearing safety shoes and safety glasses . Consider safety issues such as extreme weather conditions (e.g., heat, cold, lightning) . Wear a hard hat if the work site situation includes the possibility of falling objects. Do not work within 6 feet of a 6 foot drop off without fall protection equipment .
7	Determine the need and arrangement of scaffolding and equipment platforms. Ensure that all scaffolding and equipment platforms required are in place and meet applicable safety requirements. Equipment platforms are intended to provide support for the stationary reference MET ONE and support for the traversing MET ONE. Size the platforms to allow free movement over the length required to reach all traverse points and place the platform at a location that will ensure a level traverse. NOTE: Scaffolding construction requires a JCNNM work ticket with an ESH-3/Facility Management Unit safety review. Scaffolding MUST BE inspected by JCNNM safety BEFORE EACH USE . Appropriate safety devices MUST BE used at all times.
8	Ensure that the aerosol injection point(s) are at the proper location(s) and that the holes are large enough to allow for insertion of the injecting nozzle. Use professional judgment to determine injection points. The injection points should represent a reasonable, but conservative, estimate of particulate from all potential sources so that the degree of mixing can be determined at the sampling location. Typically, one injection point in the cross section of a single duct is sufficient, but multiple duct locations may also be required. NOTE: Cutting or drilling holes in ventilation systems requires a JCNNM work ticket with an ESH-3/Facility Management Unit safety review. A Radiation Work Permit and a Spark and Flame permit are also required. Such work is NOT covered by this procedure.
9	Ensure that the aerosol measurement holes are at the required location on the exhaust stack/duct and that the holes are large enough to allow insertion of the sampling probes. Round ducts will usually require two measurement holes 90° apart with one traverse in the same plane as the major influent to the stack (i.e., same plane as the fan inlet to the stack). Square ducts will require multiple holes on one side, although holes may be located on adjacent sides to simplify sampling.

Sample probe validation

5. Isokinetic Velocity Verification The sample probe must be sized to take a near isokinetic sample. Since the sample probe was selected using a recent flow measurement report, check to ensure that the current flow conditions have not changed significantly from the time that the flow measurement report was prepared.

Steps to verify isokinetic velocity To verify isokinetic velocity, perform the following steps:

Step	Action
1	Before performing work at the measurement location, be sure you are wearing safety shoes and safety glasses . Consider safety issues such as extreme weather conditions (e.g., heat, cold, lightning) . Wear a hard hat if the work site situation includes the possibility of falling objects. Do not work within 6 feet of a 6-foot drop off without fall protection equipment .
2	Record the measurement date in block 4 on the Measurement Location, Setup, and Results form (Attachment 2).
3	Use a calibrated velocity meter or a pitot tube and calibrated electronic digital manometer to measure the stack velocity at the sampling location center point. Record the velocity in block 5 on the Measurement Location, Setup, and Results form. Determine the ratio of the measured center point velocity to the center point velocity recorded in Step 8 in the chapter <i>Measurement preparations</i> in this procedure. If the velocity is not within 25% of the earlier center point reading, contact ESH-17 for direction.

Background determination

6. Background determination Use the steps below to determine the background counts at the sample location. Provide a means at the sampling platforms to ensure the MET ONEs do not fall from the platforms. This may include physical tie-offs for the equipment, mechanical tracks on the platforms, mechanical locks (c-clamps) or any other reasonable means to ensure the security of the equipment. Samples are taken simultaneously with both MET ONEs under the control of the system computer. All pertinent information (count time, total counts, counts in each channel, etc.) will be recorded from the MET ONE to the computer. **The setup and operation of the computer is not a part of this procedure.**

Steps to determine background counts

To determine background counts, perform the following steps:

Step	Action
1	Place the MET ONEs on the platforms at the sampling location.
2	Connect an airflow meter to each MET ONE sensor inlet tube and adjust the AIR FLOW control to withdraw a 2 acfm sample.
3	Insert the sampling probes into the stack and connect them to the MET ONEs. During the background measurements, ensure that no surrogate aerosol is injected.
4	Place one MET ONE sampling probe near the stack center point. Place the other MET ONE sampling probe at the first traverse point.
5	Perform four measurements sampling with both MET ONEs for a sufficient time to obtain a suitable background count (one minute samples or a maximum of 10^5 total particles counted). The sample times may vary between background measurements. Steps 6 through 8 should be completed only if the background appears to be $> 10^4$ total particle counts per minute.
6	Determine the coefficient of variation of the total counts for the four traverse data sets.
7	If the coefficient of variation is less than 0.30, continue with Step 8; if not, repeat the background sampling. If the coefficient of variation remains greater than 0.30 after repeat sampling, accept this as valid and continue the measurements.

8	Calculate the background average concentration plus one standard deviation for each size range. Multiply the average for each size range by 5. This is the <u>minimum acceptable surrogate aerosol count</u>. Record this and the background CofV for each size range in block 6 on the Measurement Location, Setup, and Results form (Attachment 2).
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Aerosol injection

7. Aerosol injection

Use the steps below to start the aerosol injection and adjust the injection to a proper rate to ensure sufficient surrogate aerosol at the sampling point without creating coincidence counting. Perform these steps for each injection position.

Steps to inject aerosol

To inject aerosol and adjust the injection rate, perform the following steps:

Step	Action
1	Read the Material Safety Data Sheet (MSDS) for the liquid vacuum pump oil (di-2-ethylhexyl sebacate) used to create the aerosol.
2	Be sure you are wearing safety glasses. Connect an air line from the aerosol generator to a 60 psig (maximum) air supply. This may be a portable air compressor or a facility air service line.
3	Record the number of injection points and the injection positions (distance from duct wall) in block 7 on the Measurement Location, Setup, and Results form (Attachment 2). Include a brief description of the injection point(s).
4	Insert the aerosol generator discharge tube into the duct at the first injection point. Insert the discharge tube so the outlet is located at the point in the cross section identified as the injection position.
5	Start the aerosol generator.
6	Adjust the aerosol generator output so that the reference MET ONE total particle concentration is not greater than 400,000 total counts per minute. Ideally, the injection rate should be set such that the surrogate aerosol concentration at the reference MET ONE is approximately 300,000 – 320,000 total counts per minute.
7	Repeat steps 3 through 6 for each point.

Traverse measurements

8. Traverse measurements Perform the steps below to obtain the actual concentration measurements across a traverse. This process assumes that *Background determination* and *Aerosol injection* steps have been completed and the equipment is still in position.

Steps to obtain concentration measurements To obtain concentration measurements, perform the following steps:

Step	Action
1	Ensure that the reference probe is near the center point, but clear of the path of the traversing probe.
2	Set the traversing probe to the first traverse point.
3	Using the system computer, sample with both the traversing MET ONE and the reference MET ONE for sufficient time to obtain at least the minimum count of 10mm particles per sample. Use this same sample time for all measurements of each traverse.
4	Move the traversing probe to the next traverse point and repeat Step 3 until all traverse points have been measured along this axis.
5	Reverse the direction of movement of the traversing probe and repeat Step 4. For square ducts with multiple holes along one side of the duct, this will require inserting the traversing probe into each hole and repeating steps 4 and 5.
6	After completing the first traverse, let the traversing MET ONE be the reference MET ONE, and vice versa, then repeat steps 1 through 5. For round ducts, this traverse will be 90° from the original traverse and will conclude one set of traverses . For square ducts with multiple holes along one side of the duct, repeating steps 4 and 5 for each hole will conclude one set of traverses.
7	Repeat each set of traverses a minimum of 2 times.
8	Repeat steps 1 through 7 for each additional injection position. The aerosol injection steps must also be completed for each additional injection position.
9	After completion of the aerosol concentration profile measurement, stop aerosol generation and remove all equipment. Replace covers on all holes used during this procedure.
10	Contact the facility RCT to clear equipment used to perform measurements in potentially radioactive stacks. If radioactive contamination is detected, trained and qualified personnel must decontaminate the equipment before being removed from the site.

12	Record the computer data file name in block 8 on the Measurement Location, Setup, and Results form (Attachment 2).
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Final report

Report

The **ESH-5 staff member** responsible for the measurements prepares and submits the final report on each particulate mixing study to ESH-17. The final report must outline a general overview of the testing procedure, deviations from the procedure, observations and final conclusions. An **ESH-17 staff member** reviews the report before using the reported data and submitting the report to the ESH-17 records coordinator.

Steps to prepare and submit the final report

To prepare and submit the final report, perform the following steps:

Step	Action
1	Calculate the mean normalized particle counts for the appropriate channels for each traverse point measured. Average each group of similar traverses and calculate a standard deviation and CofV for each group. Record the results in block 9 on the Measurement Location, Setup, and Results form (Attachment 2).
2	Provide comments in block 10 on the Measurement Location, Setup, and Results form, if appropriate. Record 'None' if there are no comments.
3	Attach graphs for each series analyzed to the Measurement Location, Setup, and Results form.
4	Attach any additional analysis agreed upon between ESH-5 and ESH-17 to the Measurement Location, Setup, and Results form.
5	Include the completed Measurement Location, Setup, and Results form (Attachment 2) and the completed MET ONE Performance Verification forms (Attachment 1) in the report.
6	Submit the items described in steps 1 through 5 as the final report to ESH-17 within 15 working days of performing the measurements .

NOTE: Regarding additional analyses in Step 4, if the CofV of the >10µm particles channel is < 20%, then only analyze the >10µm and the 5.0 – 10.0 µm channels, but if the CofV of the >10µm particles channel is >20%, then also analyze for the 0.3 – 5.0 µm particles channel.

Final report, continued

Steps to review the final report

To review the final report, perform the following steps:

Step	Action
1	Examine the report and ensure that it includes: <ul style="list-style-type: none">• a completed Measurement Location, Setup, and Results form (Attachment 2)• a completed MET ONE Performance Verification form (Attachment 1)• all associated graphs (attached to the Measurement Location, Setup, and Results form)• a formal write-up
2	If any of the above items are missing, contact ESH-5 to request the required documentation.
3	After reviewing the complete report, submit it to the records coordinator within 15 working days after receipt of the report from ESH-5.

Records resulting from this procedure

Records

ESH-17 personnel must submit the following records generated as a result of performing this procedure to the ESH-17 records coordinator **within 15 working days** of receipt of the report from ESH-5:

- final report from ESH-5, containing the following:
 - a completed Measurement Location, Setup, and Results form (Attachment 2)
 - a completed MET ONE Performance Verification form (Attachment 1)
 - all associated graphs (attached to the Measurement Location, Setup, and Results form)
 - a formal write-up

Air Quality Group

MET ONE PERFORMANCE VERIFICATION

Page 1 of 2

This form is from ESH-17-104

1. MET ONE Information:

Model: _____ Serial Number: _____

Calibration Expiration Date: _____ LANL Number: _____

2. Calibration Checks:

A. Airflow Calibration Check:

Test Date: _____

Airflow adjustable to 2 acfm?

☐ Yes

☐ No

B. Zero Count Purge Test:

Test Date: _____

Zero Counts?

☐ Yes

☐ No

3. MET ONE Calibration Verification:

Test Date: _____

Particle Size: _____ μm

Correct Spectrometer Channel?

Total particle count: _____

☐ Yes

counts/min

☐ No

Particle size: _____ μm

Correct Spectrometer Channel?

Total particle count: _____

☐ Yes

counts/min

☐ No

Particle size: _____ μm

Correct Spectrometer Channel?

Total particle count: _____

☐ Yes

counts/min

☐ No

4. Comments:

MET One performance verification acceptable?

☐ Yes

☐ No

Measurements by:

Signature _____

Print name _____

Z-Number _____

Date ____/____/____

ESH-17 review by:

Signature _____

Print name _____

Z-Number _____

Date ____/____/____

Air Quality Group

MEASUREMENT LOCATION, SETUP, AND RESULTS

Page 1 of 2

This form is from ESH-17-104

TA: _____ Building: _____ Exhaust Stack: _____

1. Measurement Location Description:

2. Measurement Location Velocities From Flow Report: Report Date: _____

Average Velocity (Flow Report): V_{avg} = _____ afpm

Center Point Velocity (Flow Report): V_{cp} = _____ afpm

Sample Nozzle Serial Number: _____ Internal Diameter: _____ in

3. Profile Traverse Spacing:

☐ Round Exhaust Stack / Duct

Diameter: _____ in:

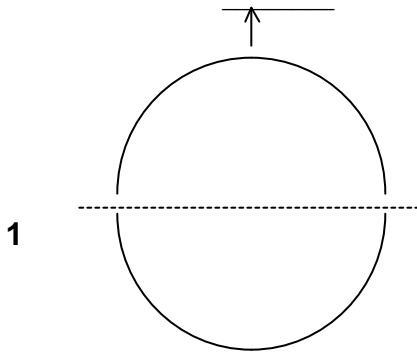
☐ Rectangular Exhaust Stack / Duct

Width: _____ in

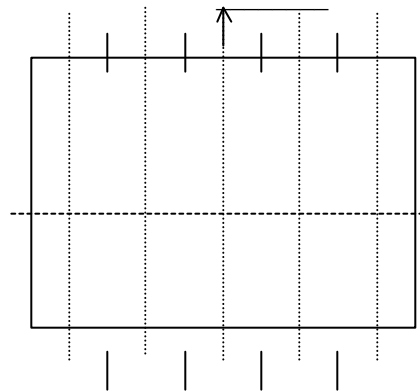
Depth: _____ in

Number of Traverse Points: _____

Indicate Location of Traverse Points and Direction Below:



2



1

2

3

4

5

Traverse Point Distance From Inside Stack Wall (To Nearest 1/8 Inch)

- | | | | | | |
|----------|----------|-----------|-----------|-----------|-----------|
| 1. _____ | 5. _____ | 9. _____ | 13. _____ | 17. _____ | 21. _____ |
| 2. _____ | 6. _____ | 10. _____ | 14. _____ | 18. _____ | 22. _____ |
| 3. _____ | 7. _____ | 11. _____ | 15. _____ | 19. _____ | 23. _____ |
| 4. _____ | 8. _____ | 12. _____ | 16. _____ | 20. _____ | 24. _____ |



Air Quality Group

MEASUREMENT LOCATION, SETUP, AND RESULTS, continued

Page 2 of 2

This form is from ESH-17-104

4. Measurement Date:

Date: _____

5. Isokinetic Velocity Verification:

Velocity Center Point (measured): V_{cpm} = _____ afpm

$(1 - V_{cpm} / V_{cp}) \times 100\%$ = _____ MUST BE LESS THAN 25%

6. Background Determination:

Total Time: _____ sec

1. Channel:	0.3 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
2. Channel:	0.5 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
3. Channel:	1.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
4. Channel:	2.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
5. Channel:	5.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
6. Channel:	10.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____

7. Aerosol Injection:

Number of Injection Points: _____

Injection Positions (distance from duct wall):

1. _____
2. _____
3. _____

Description of Injection Points and Positions: (Attach additional sheets if necessary)

8. Data File:

Data File Name: _____

9. Results:

1. Range: 0.3 - 0.5 μ m	O/A CofV: _____	2/3 CofV: _____
2. Range: _____	O/A CofV: _____	2/3 CofV: _____
3. Range: _____	O/A CofV: _____	2/3 CofV: _____
4. Range: 5.0 - 10.0 μ m	O/A CofV: _____	2/3 CofV: _____
5. Range: > 10 μ m	O/A CofV: _____	2/3 CofV: _____

10. Comments:

Measurements by:

Signature _____

Print name _____

Z-Number _____

Date _____/_____/_____

ESH-17 review by:

Signature _____

Print name _____

Z-Number _____

Date _____/_____/_____

MET ONE PERFORMANCE VERIFICATION

Page 1 of 2

This form is from ESH-17-104

1. MET ONE Information:

Model: _____ Serial Number: _____

Calibration Expiration Date: _____ LANL Number: _____

2. Calibration Checks:**A. Airflow Calibration Check:**

Test Date: _____

Airflow adjustable to 2 acfm?

☐ Yes☐ No**B. Zero Count Purge Test:**

Test Date: _____

Zero Counts?

☐ Yes☐ No**3. MET ONE Calibration Verification:**

Test Date: _____

Particle Size: _____ μm

Correct Spectrometer Channel?

Total particle count: _____ counts/min

☐ Yes☐ NoParticle size: _____ μm

Correct Spectrometer Channel?

Total particle count: _____ counts/min

☐ Yes☐ NoParticle size: _____ μm

Correct Spectrometer Channel?

Total particle count: _____ counts/min

☐ Yes☐ No**4. Comments:**

MET One performance verification acceptable?

☐ Yes☐ No

Measurements by:

Signature_____
Print name_____
Z-Number_____/_____/_____
Date

ESH-17 review by:

Signature_____
Print name_____
Z-Number_____/_____/_____
Date

MEASUREMENT LOCATION, SETUP, AND RESULTS

Page 1 of 2

This form is from ESH-17-104

TA: _____ Building: _____ Exhaust Stack: _____

1. Measurement Location Description:**2. Measurement Location Velocities From Flow Report:** Report Date: _____

Average Velocity (Flow Report): V_{avg} = _____ afpm
 Center Point Velocity (Flow Report): V_{cp} = _____ afpm

Sample Nozzle Serial Number: _____ Internal Diameter: _____ in

3. Profile Traverse Spacing:☐ Round Exhaust Stack / Duct☐ Rectangular Exhaust Stack / Duct

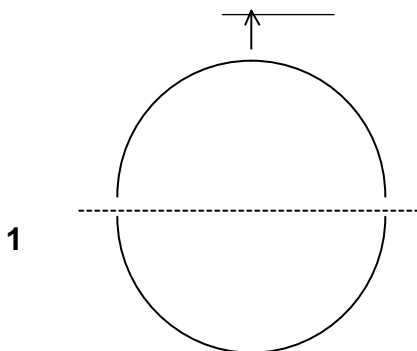
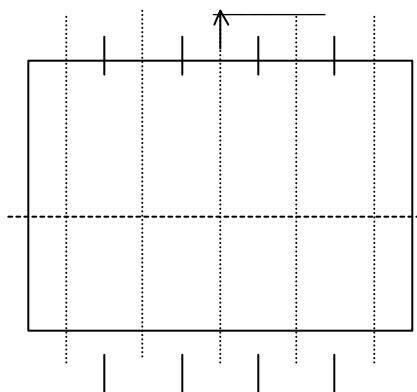
Diameter: _____ in

Width: _____ in

Depth: _____ in

Number of Traverse Points: _____

Indicate Location of Traverse Points and Direction Below:

**2****1****2****3****4****5**

Traverse Point Distance From Inside Stack Wall (To Nearest 1/8 Inch)

1. _____	5. _____	9. _____	13. _____	17. _____	21. _____
2. _____	6. _____	10. _____	14. _____	18. _____	22. _____
3. _____	7. _____	11. _____	15. _____	19. _____	23. _____
4. _____	8. _____	12. _____	16. _____	20. _____	24. _____

MEASUREMENT LOCATION, SETUP, AND RESULTS, continued

Page 2 of 2

This form is from ESH-17-104

4. Measurement Date:

Date: _____

5. Isokinetic Velocity Verification:Velocity Center Point (measured): V_{cpm} = _____ afpm $(1 - V_{cpm} / V_{cp}) \times 100\%$ = _____ MUST BE LESS THAN 25%**6. Background Determination:**

Total Time: _____ sec

1. Channel:	0.3 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
2. Channel:	0.5 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
3. Channel:	1.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
4. Channel:	2.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
5. Channel:	5.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____
6. Channel:	10.0 μ m	Total Counts: _____	CoV: _____	Avg Conc: _____

7. Aerosol Injection:

Number of Injection Points: _____

Injection Positions (distance from duct wall):

1. _____

2. _____

3. _____

Description of Injection Points and Positions: (Attach additional sheets if necessary)

8. Data File:

Data File Name: _____

9. Results:

1. Range: 0.3 - 0.5 μ m	O/A CofV: _____	2/3 CofV: _____
2. Range: _____	O/A CofV: _____	2/3 CofV: _____
3. Range: _____	O/A CofV: _____	2/3 CofV: _____
4. Range: 5.0 - 10.0 μ m	O/A CofV: _____	2/3 CofV: _____
5. Range: > 10 μ m	O/A CofV: _____	2/3 CofV: _____

10. Comments:

Measurements by:

_____ Signature	_____ Print name	_____ Z-Number	_____ Date
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ESH-17 review by:

_____ Signature	_____ Print name	_____ Z-Number	_____ Date
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